

TABLE 3.—Maximum free-air wind velocities, (m.p.s.), for different sections of the United States based on pilot-balloon observations during July 1942

Section	Surface to 2,500 meters (m. s. l.)				Station	Between 2,500 and 5,000 meters (m. s. l.)				Station	Above 5,000 meters (m. s. l.)				Station
	Maximum velocity	Direction	Altitude (m.) m. s. l.	Date		Maximum velocity	Direction	Altitude (m.) m. s. l.	Date		Maximum velocity	Direction	Altitude (m.) m. s. l.	Date	
Northeast ¹	28.2	W	1,360	6	Philadelphia, Pa.	36.4	WNW	4,270	14	Syracuse, N. Y.	68.8	NW	12,380	17	Caribou, Maine.
East-Central ²	28.0	W	1,680	6	Cincinnati, Ohio	27.3	WSW	2,750	6	Washington, D. C.	38.6	SW	9,570	23	Knoxville, Tenn.
Southeast ³	30.0	WSW	2,090	6	Charleston, S. C.	24.4	W	4,480	7	Spartanburg, S. C.	30.3	NE	9,830	14	Tallahassee, Fla.
North-Central ⁴	30.9	WSW	2,150	12	Duluth, Minn.	44.5	WNW	4,270	7	Milwaukee, Wis.	46.5	NNW	9,460	9	Alpena, Mich.
Central ⁵	30.0	WSW	1,420	9	Wichita, Kans.	30.9	NW	4,600	7	Moline, Ill.	38.4	NW	6,150	6	Des Moines, Iowa.
South-Central ⁶	31.6	SE	1,660	29	Del Rio, Tex.	24.0	WNW	3,000	9	Tulsa, Okla.	55.0	NE	19,730	31	Little Rock, Ark.
Northwest ⁷	41.2	WSW	2,310	14	Butte, Mont.	42.0	W	3,920	11	Havre, Mont.	65.0	WSW	10,660	31	Billings, Mont.
West-Central ⁸	27.0	SW	2,420	12	Casper, Wyo.	38.0	SW	5,000	11	Modena, Utah	60.8	SW	12,170	30	Winnemucca, Nev.
Southwest ⁹	24.9	ESE	2,310	22	Tucson, Ariz.	37.0	NNW	4,350	24	El Paso, Tex.	39.0	SW	10,140	29	Bakersfield, Calif.

¹ Maine, Vermont, New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, and northern Ohio.

² Delaware, Maryland, Virginia, West Virginia, southern Ohio, Kentucky, eastern Tennessee, and North Carolina.

³ South Carolina, Georgia, Florida, and Alabama.

⁴ Michigan, Wisconsin, Minnesota, North Dakota, and South Dakota.

⁵ Indiana, Illinois, Iowa, Nebraska, Kansas, and Missouri.

⁶ Mississippi, Arkansas, Louisiana, Oklahoma, Texas (except El Paso), and western Tennessee.

⁷ Montana, Idaho, Washington, and Oregon.

⁸ Wyoming, Colorado, Utah, northern Nevada, and northern California.

⁹ Southern California, southern Nevada, Arizona, New Mexico, and extreme west Texas.

RIVER STAGES AND FLOODS

BY BENNETT SWENSON

The month was characterized by an uneven geographic distribution of rainfall. Excessive local rains occurred in many areas including parts of Texas, Minnesota, Iowa, northern Wisconsin, southwestern Illinois, Missouri, Pennsylvania, New York, and eastern Kentucky. These rains resulted in numerous localized but damaging floods. The highest stages of record were established in some cases notably in the upper Allegheny River Basin where phenomenal rates of rainfall occurred on July 17-18.

While parts of the Ohio Valley, the Northeastern States, the upper Mississippi Valley, southeastern Texas, and the far Northwest had above normal precipitation, most of the remainder of the country had a decidedly dry month.

Hudson Bay drainage.—A minor flood occurred in the Red River of the North from the 7th to the 12th of June. A stage of 6.4 feet was reached at Wahpeton, N. Dak. (flood stage 6 feet), on June 8 and a stage of 17.7 feet at Fargo, N. Dak. (flood stage 17 feet), on June 11. The flood was caused by locally heavy rains on the morning of June 5, followed by lighter amounts during the next 48 hours and heavy amounts again on the morning of the 8th; on the morning of the 5th, 2.76 inches of rain was recorded at Mobridge, S. Dak., and 2.15 inches at Oaks, N. Dak. (both 24-hour amounts). On the morning of the 8th, Ashley, N. Dak., reported 1.95 inches.

Light overflows took place in Moorhead, Minn., and Fargo, N. Dak., but the damage was slight.

Atlantic Slope drainage and Ohio River Basin.—On July 17-18, thunderstorms with excessive precipitation over the north-central counties of Pennsylvania and bordering counties of New York caused disastrous flooding in the upper Allegheny River Basin, and in the Sinnemahoning Creek Valley, a tributary of the West Branch of the Susquehanna River.

The flood damage area covered about 2,000 square miles in the headwaters of the Allegheny, and in the Clarion River and the Sinnemahoning Creek, in parts of Allegheny and Cattaraugus Counties in New York, and in Cameron, Elk, McKean, and Potter Counties in Pennsylvania. The following is a brief outline of the flood conditions in representative towns in the area most seriously affected:

Ridgway, Pa.—Most of the principal industries and about 10 percent of the residential section were flooded by the Clarion River and Elk Creek. The river rose 66 inches in 1½ hours and was above flood stage from 9:30 p. m. of the 18th to late night of the 19th. This flood was the maximum of record and was 26 inches higher than the flood of March 17, 1936.

Johnsonburg, Pa.—About 25 percent of the business section and 10 percent of the residential section were flooded. One life was lost. The flood waters rose so rapidly that the primary concern in the flood zone was evacuation so that little property was salvaged.

Flooding at this point is caused by the east and west branches of the Clarion River. The crest was 7.5 feet above the flood of March 17, 1936, and is the maximum of record. The river was out of its banks for about 12 to 18 hours.

Emporium, Pa.—The town was partially protected by dikes which had been erected following the 1936 flood, and it was not until the dikes were overtopped that the main part of the town was flooded. Most of the residents, north of the railroad tracks, did not remove their portable belongings before the dikes were overtopped and, therefore, were unable to save much of their property. This was the first time that the main business section of the town had been flooded. About 60 percent of the town was flooded. Three lives were lost.

Flooding at this point was caused by Sinnemahoning Creek. The creek was out of its banks for about 24 hours. This flood was about 34 inches higher than the flood of March 17, 1936, and about equal to the flood of June 1889.

Austin, Pa.—The principal industries and the business section and 80 percent of the residential area were flooded. The major damage was caused by failure of an earth dam 2 miles above the town. The water was about 4 to 5 feet deep on the main street.

Coudersport, Pa.—About 50 percent of the business and 25 percent of the residential sections were inundated. Flooding was caused by the overflowing of the Allegheny River. The river was out of bank about 18 hours. This is the maximum flood of record.

Port Allegany, Pa.—Six lives were lost. All major industrial plants, the entire business district, and about 50 percent of the residential areas were flooded. Fire also destroyed one home and a silk mill.

This town probably received the greatest damage per capita of any in the flood zone. The flood waters rose so rapidly that the only concern was to evacuate the people and very few portable goods were removed above the flood level. Flooding at this point was caused by the overflowing of Lille Bridge Creek and in the Allegheny River. The streams were out of bank for about 24 hours and the crest was reached about 1 p. m. of the 18th.

Olean, N. Y.—The city was partially protected by a dike system and it was not until the dikes were topped that the major flooding occurred. Four lives were lost. About 10 percent of the business and 70 percent of the residential sections were inundated.

The flooding was caused by Olean Creek and the Allegheny River. The river was above the flood stage for about 36 hours. This is the maximum flood of record.

All outlying villages and towns received severe damage and the damage was also severe in all rural sections of the flood zone. Statistics on the flood losses have not been completed and unofficial reports of phenomenal rainfall intensities have not yet been fully verified. A further report on these floods will be made in a later issue of the REVIEW.

Damaging local floods also occurred in the headwaters of the Big Sandy and Kentucky Rivers in eastern Kentucky on July 8-9, with the greatest damage in Knott, Perry, Floyd, and Letcher Counties. Jackson, Ky., reported 4.77 inches of rain in 24 hours preceding the morning of the 8th.

Several small towns were completely flooded and damage to buildings and crops was heavy. Three lives were lost and property damage has been estimated at \$1,500,000.

Flood stage was not reached at any station on the main channel of the Big Sandy River but two stations on the North Fork of the Kentucky River, Hazard and Jackson, Ky., exceeded flood stage. At Hazard the crest was 21.5 feet (flood stage 20 feet) and at Jackson, Ky., 32.4 feet (flood stage 28 feet), on July 9.

Flooding occurred in the headwaters of the Hocking River on June 30-July 1 from excessive rains. At Lancaster, Ohio, 3.48 inches of rain fell between 5:05 and 6:20 p. m., June 30, with an additional 0.37 inch between 5:35 and 6:45 p. m. July 1.

Great Lakes Drainage.—Exceptionally heavy rains occurred in extreme northern Wisconsin on July 16-17. Some of the rainfall amounts during this storm were as follows: Ashland, 3.01 inches; Bayfield, 8.68 inches; Big St. Germain Dam, 4.98 inches; Brule Island, 5.06 inches; Land O'Lakes, 4.84 inches and Rest Lake, 8.06 inches.

The greatest damage occurred at Bayfield, which is located on a steep hillside rising from Lake Superior. The heavy rain began at 9:30 p. m., July 16 and continued intermittently until 9:30 a. m., July 17, during which 12 hour period 8.52 inches of rain fell. The water concentrated in two ravines behind the city and swept through the center of the business district, forming gullies 50 feet wide and 20 feet deep in places. Along the lake shore, sand was filled in to a depth of 10 feet. The total damage has been estimated at \$500,000.

Upper Mississippi River Basin.—Extensive flooding occurred during the months of June and July in the upper Mississippi Basin. The flooding began late in May when heavy rains fell principally over the Chippewa and Wisconsin River Basins. Frequent rains during the month of June resulted in further flooding in the tributary streams particularly in Minnesota, Iowa, and Missouri. A general rise began in the Mississippi River early in June. The flooding in the Mississippi extended from Winona, Minn., to just above its junction with the Ohio River beginning in the upper reaches on June 3 and continuing at Cape Girardeau, Mo., until July 10. Reports on these floods

are submitted by the river district officials as given below.

River District of La Crosse, Wis., comprising the Mississippi River and tributaries from Hastings, Minn., to lock and dam No. 8:

SOURCE OF FLOOD

Rainfall was well distributed throughout the first 3 weeks in May. Some locally heavy thundershowers fell over the entire river district resulting in high groundwater table and preparing the soil for low initial loss for the extended and heavy rains which fell the last week in May. Widespread rains of the thunderstorm type occurred from the 25th to the 31st of May, the period which may be considered flood producing with the center of mass of rainfall on the 29th. Although subsequent light rains fell during the first week in June, and aggravated to some extent the flood conditions which followed; the average storm index was calculated as 2.40 inches over the 63,000 square miles of drainage area above La Crosse, Wis.

HYDROLOGIC FACTORS

The focal point of the rains during the period appeared in the area just east of Minneapolis and St. Paul, Minn., covering the counties of Washington in Minnesota and Pierce and St. Croix of Wisconsin. The amounts of precipitation and the approximate areas involved are as follows:

Amount of precipitation (inches):

	Areas involved (square miles)
7.00-----	600
6.00-----	2,900
5.00-----	4,000
4.00-----	5,500
3.00-----	10,000
2.00-----	15,000
1.00-----	21,800
0.50-----	3,000
0.25-----	300

From the factor of actual flood stream-flow it appears that the surface run-off or amount of rainfall actually finding its way into the main channel was 11% of the average basin fall of 2.40 inches.

METEOROLOGICAL ANALYSIS—STORM OF MAY 25-31

On the first day of extended rainfall, a low-pressure trough appeared over the central plains with a strong inflow of maritime-tropical air from the Gulf of Mexico. Continental polar air prevailed over the eastern half of the country. On the 26th these conditions continued with a cold front extending from Sault Sainte Marie, Mich., to northern Nebraska. By the morning of the 27th warm front activity intensified over northern Nebraska, producing heavy rains over North Dakota and the extreme upper Mississippi Valley. On the 28th and 29th the area of heaviest rainfall progressed eastward with the movement of the frontal zone and occurred as a result of lifting and intense convergence of the moist tropical air in advance of, and with the passage of the front. Heavy rains fell in the Chippewa Valley at this time. The strong high pressure over the East played a major role in the retardation of fronts resulting in prolonged precipitation.

On the 30th and 31st a stationary front in the upper Mississippi Valley caused continuous but light rains to fall over most of the drainage area of this district.

COMPARISON OF FLOOD INTENSITY

Floods occurring at this time of the year are commonly termed June "rises" and are much less numerous than the spring rises or even those occurring in the fall. The June rises are invariably caused by heavy extended rains of the thunderstorm type.

The highest flood on record, occurring in June 1880, was of this type. The present flood was the second highest on record belonging to this classification. The previous high flood exceeding the present flood crest, 13.0 feet at La Crosse, Wis., on June 5, was 13.7 feet on April 17, 1922. This definitely classifies the present June flood as one of maximum intensity. The occurrence at this time of the year necessarily involves great prospective crop losses.

DAMAGE

By far the greater damage was done to agricultural interests and highways, partly due to excessive downpours of rain. Approximately 20,000 acres of land with prospective crops were affected with about one-third this area in the actual flood plain of the streams. Building losses were comparatively small, this being confined to summer homes and cottages on low ground. Some suspension of business resulted and the railroad from Wabasha, Minn., to Eau Claire, Wis., was closed for about 1 week due to track flooding. The main railroad roadbeds along the river were not affected.

Damages are listed in the following table:

1. Tangible property totally or partially destroyed, such as buildings, fences, factories, highways, bridges, railroads, etc.....	\$626, 075
2. Agricultural losses:	
(a) Matured crops.....	47, 000
(b) Prospective crops involving 20,000 acres.....	699, 500
(c) Livestock and other movable farm equipment.....	15, 580
3. Suspension of business, including wages of employees.....	41, 700
4. Money value of property saved by flood warnings.....	175, 000

In addition to the main channel and tributary floods occurring the first week in June, described above, maximum floods during the last 3 days in June took place on the Root, La Crosse, and Whitewater tributary streams. The following will deal with those particular floods.

SOURCE OF FLOOD

Heavy thunderstorms with several periods of excessive rains occurred in the basins of the above-named tributaries beginning in the morning of the 28th and extending into the early morning of the 29th. At La Crosse, Wis., three excessive falls were recorded, one beginning at 9:19 a. m., one at 3:43 p. m., and one at 7:57 p. m. During the first period 1.11 inches fell in 20 minutes and 1.06 inches at the same rate in the second period. The storm total at La Crosse was 3.97 inches and 5.06 inches at Sparta, Wis. In the Root River Valley embracing a drainage area of 1,560 square miles, excessive rains of maximum proportion fell in the center of this area. Houston, Minn., reported 2.68 inches on the 28th, and Spring Grove, Minn., 3.19.

In the Whitewater drainage area, amounts varied greatly over the basin, as only 2.20 inches was reported at Beaver, Minn., yet maximum flood conditions followed.

It was apparent from synoptic reports and local conditions at La Crosse, Wis., that the area of heaviest rainfall was central over a belt covering the Root River Basin extending northeastward into the Whitewater, then eastward into Wisconsin over the lower Black River and La Crosse River Basins.

METEOROLOGICAL ANALYSIS—STORM OF JUNE 28-29, 1942

Contributing factors to the periods of excessive precipitation which occurred over the Root, Whitewater, and La Crosse River drainage basin during June 28 and early June 29, 1942, are as follows:

On the morning of June 28 a warm front separating exceptionally moist and unstable tropical air to the south and a shallow wedge of transitional polar air to the north lay along a line from east-central Minnesota southeastward along the Wisconsin-Minnesota border into central Illinois. At the same time a mass of polar air was moving eastward over Minnesota and Iowa with its forward edge extending along a line from east-central Minnesota south and southwestward through the southwestern corner of Iowa. Soundings taken in the moist tropical air at St. Louis, Mo., Omaha, Nebr., and St. Paul, Minn., show that the mixing ratio in the lower levels was in excess of 15 g./kg., and the air was both conditionally and convectively unstable. The intense general thunderstorm activity which produced the excessive rainfall during three periods between the morning of the 28th and the early morning of the 29th was due to the release of the potential energy in this moist unstable air mass.

During the first period (morning of the 28th) the potential energy was realized through horizontal convergence and lifting of the tropical air over the shallow wedge of polar air to the north. The second period occurred in the warm sector where latent energy was released largely through intense convergence of the moist tropical air preceding the passage of the cold front. The last period of intense rainfall was due to lifting and convergence of the unstable air associated with the passage of the cold front.

DAMAGES

The statistics of damage for these tributary floods are as follows:

1. Tangible property, buildings, highways, bridges, railroads.....	\$24, 000
2. Agricultural losses:	
(a) Matured crops.....	20, 000
(b) Prospective crops.....	122, 500
(c) Livestock, farm equipment.....	6, 250
3. Suspension of business.....	10, 000
In this is included the suspension of traffic on the Chicago, Milwaukee & Saint Paul Railroad up the Root River Valley. Tracks were covered with water in several places.	
4. Value of property saved by warnings.....	7, 000

FLOOD CONDITIONS

On June 30, maximum flood conditions prevailed on both the Root and La Crosse Rivers and to a lesser extent on the Whitewater, where losses were greater due to excessive rains on upland areas than on the actual flood plain. On the Root River at Houston, Minn., the peak stage was 678.50 feet (m. s. l. elev.) at 7 a. m. of the 30th. (Zero elevation 1912 Adj. is 661.95.) The flood stage is 675 feet, the elevation at which floodwaters begin to cover agricultural land. The peak at West Salem on the La Crosse River was 7.66 feet on June 30th. (Flood stage approximately 7 feet.) and at Beaver on the Whitewater, 7.3 feet on the 29th. (Flood stage approximately 7 feet.) All gaging stations mentioned in the above are maintained by the U. S. Engineer Office at St. Paul, Minn. Due to the local character of the excessive rains, the Zumbro River Valley adjoining this experienced no flood conditions.

River District of Dubuque, Iowa, comprising the Mississippi River and tributaries between lock and dam Nos. 8 and 12:

Precipitation, during May, was quite well distributed throughout most of the central and northern portions of Wisconsin. Although the total amounts prior to May 19 had not been particularly great, they had been sufficient to establish a rather high soil-water content. From the 19th to the 25th of May, inclusive, the precipitation was scattered and mostly light, but the degree of soil saturation remained rather high, and it was increased by the general rain-fall of May 26, so that a high measure of run-off began almost immediately with the occurrence of the widespread and rather generally heavy rains which set in on the 28th, which were frequent to June 6, and intermittent thereafter to June 12. Precipitation was almost entirely in the form of local showers and thunderstorms, but they were so numerous and so frequent that, in the general effect, the results closely simulated conditions to be expected from general, uniformly distributed, and substantial rains.

Approximately half of the total precipitation for May fell in the latter period of 1 week. There were two areas of peak rainfall concentration, the centers being approximately at River Falls, Wis., and over a triangular area with apexes at Wausau, Knowlton, and Marshfield, Wis. Since River Falls is not in the Dubuque district, and will have to be considered with the precipitation over Minnesota, and because to do so would result in duplication, it is not being discussed in this report.

The Wausau-Knowlton-Marshfield triangle is approximately on the divide between and extends to the Wisconsin River on the east and to the Black River on the west. For the reasons set forth above, the following discussion is limited to the Wisconsin and Mississippi Rivers.

Above Wisconsin Dells, Wis., the Wisconsin River Valley experienced precipitation of such frequency and intensity during the last week of May 1942 that totals aggregated approximately half the monthly total, and were close to or exceeded the entire monthly normal. As previously mentioned, soil conditions were already highly favorable for a high measure of run-off. Consequently, the exceptionally heavy storms of the last 3 or 4 days of the month, particularly over the triangle already mentioned, produced a severe, flashy flood which crested at Knowlton at 6 p. m. on May 31. This has been termed as a severe flood merely on the basis of the crest stage and comparison with past records. It was not record breaking, however, and it did not do a large amount of damage in the Knowlton area. This absence of extensive damage was due to the fact that much of the flooded area has been acquired for reservoir area, currently in development, and the land has been unoccupied.

As this crest proceeded downstream it passed Wisconsin Rapids, Wis., at 6 p. m., June 1, and Portage at 3 p. m., June 4. Thereafter it tapered off considerably, primarily because the rainfall had not been particularly great at and below Wisconsin Dells. Precipitation continued to fall, almost daily, as the crest proceeded downstream. Ordinarily rains which fall after the crest occurs at Wisconsin Rapids have little or no influence upon subsequent crest stages at downstream points, but in this instance a second, but much less severe, crest developed at Knowlton at 7 a. m. on June 7. This second crest was largely "damped-out" before it reached Wisconsin Dells, but the rainfall period responsible for its development had extended well downstream and it made necessary an almost daily revision upward of crest estimates.

The time of the Wisconsin River flood was such that upon entering the Mississippi, it joined with the combined crests from above LaCrosse to produce, at Dubuque, the second highest stage of record for June. The crest was 19.34 feet at 2:15 a. m. on the 12th. The one higher June crest was 21.7 feet, the all-time high-water mark, recorded in 1880. Flood stages, however, were not attained at the other Mississippi river substations between LaCrosse and Dubuque.

Monetary losses, as river-flood damage, along the Wisconsin River totaled approximately \$23,710 a substantial percentage of

which was in the Wisconsin Rapids area. Reports received indicated only about a \$1,000 saving in property as a result of warnings, but there were, in addition, numerous comments indicating extensive savings, but without statements regarding the monetary values.

Along the Mississippi River (Dubuque district) the losses aggregated \$65,276. The losses of prospective crops were especially heavy in the Lansing, Iowa, area. The next largest losses were in the suspension of contract construction work on Government boats and a new highway bridge over the Mississippi, at Dubuque. Operations at the Dubuque Municipal Airport had to be suspended, but most of the flying was continued elsewhere. Each of those activities suffered delays or suspension of activities for about three weeks.

River District of Davenport, Iowa, comprising the Mississippi River, and tributaries, between lock and dam Nos. 12 and 18:

The Rock River remained relatively high during the first 2 weeks of June 1942. On June 12 a rain of 2.45 inches was reported at Moline, Ill., and 1.89 inches at Galva, Ill. These rains and other moderate ones nearby, resulted in a crest stage of 10.05 feet at Moline, at 1 a. m., June 15. No material damage resulted from this rise.

Excessive local rains near Iowa Falls, Iowa, and heavy to excessive local rains in adjacent sections during the first 4 days of June 1942 resulted in flash floods on the Cedar River and tributaries and considerable soil erosion in Hardin, Grundy, and Black Hawk Counties in Iowa. The heaviest rain reported to Davenport was 6 inches on June 2 and 3, but totals around this amount were reported in nearby areas. Waterloo, Iowa, showed a stage of 12.2 feet at 2 p. m., of June 4th, the flood stage being 12 feet. One life was lost as the result of the flood and monetary losses have been estimated at over \$340,000. Of this amount, more than \$200,000 is attributed to crop losses. These figures do not include the damage to farm lands by erosion resulting from the excessive rains which are believed to reach a total of \$1,000,000.

The mid-June flood on the Mississippi River in the Davenport River district had its inception in the upper reaches of the Wisconsin River Basin, in the last 4 days of May. Amounts of precipitation ranging from 5.84 inches at Wausau, Wis., to less than an inch at other places, were reported in this territory and the average was slightly over 3 inches for a 4-day period from May 28 to May 31. Heavy local rains following these conditions were reported on June 2-3, 6-7, and 12-13 over the upper Mississippi Valley which increased flood crests and were the primary cause of flood damage in the Davenport River district.

On the morning of June 3 and continuing through June 7, a steady rise on the Mississippi River for a week to 10 days was forecast, preparing people for flood warnings which were first issued on June 8.

The following crest stages were reached: Clinton, Iowa, 17.8 feet on June 13-14; Davenport, 15.2 feet on June 14-15; Muscatine, Iowa, 17.6 feet; and Keithsburg, Ill., 14.05 feet on June 15.

The losses from the flood waters have been estimated at \$134,000, of which \$98,000 is attributed to crops. No lives were lost.

River District of Burlington, Iowa, comprising the Mississippi River, and tributaries except the Des Moines River, between lock and dam Nos. 18 and 24:

A series of rains over portions of Minnesota, Wisconsin, Iowa, Illinois, and Missouri during the first part of June 1942 caused moderately heavy flooding on the Mississippi in this district during the middle and latter part of the month.

Flood warnings were issued June 6. Flood stage was first exceeded on June 9 at Hannibal, Mo., and the last station to pass flood stage was Burlington, Iowa, on June 14. The first date that the river fell below flood stage at any point was on June 19 at Burlington, Iowa, and the last point to fall below flood stage was at Louisiana, Mo., on June 28. The following crest stages were reached: Burlington, 15.5 feet, and Keokuk, Iowa, 15.8 feet, on June 16; Quincy, Ill., 17.7 feet on June 17; Hannibal, Mo., 17.7 feet on June 19; and Louisiana, Mo., 16.3 feet on June 20.

Heavy rains in northeastern Missouri near the end of the month caused the Salt River near New London, Mo., to rise rapidly reaching a crest of 25.5 feet (6.5 feet above flood stage) on June 29.

About 71,000 acres of prospective crops were flooded causing a loss of about \$910,000. The most severe damage was in Pike County, Ill., where 44,600 acres were inundated with a loss of over \$580,000. The total losses (all classes) in the Burlington river district have been estimated at about \$927,000.

The River District of Cairo, Ill., comprising the Mississippi River from Cape Girardeau, Mo., to New Madrid, Mo.:

At the beginning of June 1942 the stage of the Mississippi River at Cape Girardeau, Mo., was moderately high, but a fall was in progress; by the 7th of the month the water level had declined to 20.1 feet. On the 7th, a series of rains began in the lower Missouri Valley and from that date until the 27th precipitation was reported daily at stations along that river and its numerous tributaries. Heavy rains also occurred during that period over the Illinois River watershed and over the Mississippi River above Cairo, Ill. These factors combined to produce a flood in the Mississippi River above Cairo. Throughout the month the Tennessee and Ohio Rivers remained low, a condition which decreased the flood height in the vicinity of the mouth of the Ohio.

The crest stage at Cape Girardeau, 36.9 feet, on July 2, while the highest ever reached during a summer month since establishment of the station on January 1, 1891, fell considerably short of the highest of record, 40.04 feet, which occurred on April 20, 1927, and the high-water mark of 42.5 feet in July 1844. For comparison the following summer high stages are mentioned:

	feet
June 14, 1903.....	36.53
July 18, 1909.....	35.00
June 11, 1935.....	36.35

The duration of the flood is given as from June 24 to July 10, 1942; these are the inclusive dates during which readings above 32 feet (flood stage) were made at Cape Girardeau, there being no other Weather Bureau river gage along the portion of the stream considered. Below the mouth of the Ohio, flood stage was not reached; however, high water did cause some damage to corn and cotton crops planted on lowlands in that area, and these losses are listed along with those which were sustained further up-stream.

A summary of losses reported in this District follows:

STATISTICS OF MONEY LOSSES BY FLOODS

State	Tangible property	Farm property			Suspension of business	Saved by warnings
		Matured crops	Prospective crops	Live-stock		
Illinois.....	\$6,075	\$6,500	\$110,000	0	\$1,500	\$10,000
Missouri.....	400	0	77,600	\$420	1,900	8,900
Kentucky.....	200	0	79,840	0	0	0
Total for the district.....	6,675	6,500	267,440	420	3,400	18,900

NOTES

The acreage of farm land overflowed were: 4,050 in Illinois, 2,340 in Missouri, 3,200 in Kentucky—a total of 9,590 for the affected area.

The counties included in the above estimate are: Alexander, in Illinois; Cape Girardeau, Scott, Mississippi, and New Madrid in Missouri; and Ballard, Carlisle, Hickman, and Fulton in Kentucky.

No human life was lost and little harm was done to buildings.

Loss of livestock was held to a minimum by the rescue efforts of the U. S. Coast Guard unit based at Cairo, which removed a great many cows, hogs, horses, and chickens from the flooded area.

The region which was covered by water is sparsely settled and the removal of its inhabitants did not present as great a problem as in some previous floods.

A severe thunderstorm with excessive rainfall occurred in St. Louis, Mo., and surrounding territory, during the late evening of July 8, and continuing into the forenoon of July 9. The area of greatest intensity was centered over Florissant, Mo., 14 miles north-northwest of St. Louis, with another center of somewhat lesser intensity over East St. Louis, Ill. The greatest amount reported was 11 inches near Florissant from an unofficial measurement but believed to be reliable. The heaviest official measurements were 8.48 inches at East St. Louis and 7.50 inches at Grafton, Ill. The average length of duration of the storm was 11 hours.

Missouri River Basin.—Heavy rains in southeastern South Dakota, northwestern Iowa, and southwestern Minnesota late in June caused a general overflow of low

ground along the Big Sioux, Rock, and Floyd Rivers early in July, but the damage was slight.

Again late in July heavy rains occurring over approximately the same area caused moderate damage along the Big Sioux River from above Sioux Falls, S. Dak., to Sioux City, Iowa. Overflow was not as extensive as that which occurred in early June, except along Rock River from the mouth to above Rock Rapids where moderate overflow occurred and the Big Sioux from the mouth of the Rock River to below Akron, Iowa, where the overflow was nearly as extensive as in June. The crest at Akron was 18.3 feet on August 2. Below Akron the flood leveled off, due to low stages in the Missouri River.

West Gulf of Mexico drainage.—Unusually high floods occurred in the lower portions of the Guadalupe, Nueces, and Rio Grande Rivers during the early part of July. They were the result of almost continuous rains during the first 7 days of the month, becoming heavy at times. The rainfall and a comparison of the crest stages with previous high floods are shown in the accompanying table.

Floods of July 1942 in Guadalupe, Nueces, and Rio Grande Rivers and comparison with previous highest floods

Station and river	Years of record	Previous highest flood		July 1942 flood									
		Stage	date	Stage	Date	Precipitation and dates							
						1	2	3	4	5	6	7	
Guadalupe:													
Gonzales, Tex.	39	38.3	May 1929	35.1	7	0.56	T	0.08	0.48	1.79	2.62	2.53	
Cuero, Tex.	1	43.2	July 1936	33.0	8	.36	0.45	.60	.76	2.95	2.50	3.10	
Victoria, Tex.	39	30.7	July 1936	29.6	10	—	.26	.29	.44	5.64	3.01	1.96	
Nueces:													
Cotulla, Tex.	25	32.4	June 1935	11.4	11	—	.15	.65	—	1.16	3.84	—	
Three Rivers, Tex.	28	46.0	September 1919	44.8	10	—	2.80	.31	.11	1.42	2.92	2.10	
Rio Grande:													
Laredo, Tex.	26	49.6	September 1932	16.5	6	—	.76	1.20	.35	.07	3.20	—	
Rio Grande City, Tex.	31	34.8	do.	21.6	7	—	—	.03	.14	.42	.20	—	
Hidalgo, Tex.	11	26.0	do.	21.2	9	—	—	—	—	.03	—	1.00	
Mercedes, Tex.	11	22.6	September 1935	23.4	9	—	.14	.02	—	.07	.31	—	
Brownsville, Tex.	17	19.7	October 1936	19.4	11	1.12	—	.27	.01	T	.02	.12	

¹ High-water mark.

The Guadalupe and Nueces Rivers were quite low at the beginning of the month, commenced to rise rapidly by the 5th and crested generally by the 8th to 10th. At Victoria, Tex., the lowermost station on the Guadalupe, the crest stage of 29.6 feet on the 10th was just 1.1 feet below the record high stage in July 1936, and at Three Rivers, Tex., the Nueces River crested at 44.8 feet on the 10th, 1.2 feet below the record high stage of September 1919.

The stages in the lower Rio Grande were moderately high on the 1st of July from a rise which occurred during the latter half of June. The river reached flood stage at Rio Grande City, Tex., on July 7 and at Mercedes and Brownsville, Tex.; it was above flood stage from July 6 to 12. The crest stage at Mercedes, 23.4 feet on July 9, was 0.8 foot above the record high stage of September 1935 and at Brownsville the crest of 19.4 feet on July 11 was just 0.3 foot below the previous high stage in October 1936.

In the lower Rio Grande Basin the losses were confined

almost entirely to cotton and truck acreage planted inside the main levees from Brownsville to the mouth. The total losses in the flood have been estimated at about \$200,000 to matured crops and \$320,000 to prospective crops.

The losses in the Guadalupe and Nueces Rivers were as follows:

	Guadalupe	Nueces
Tangible property.....	\$5,000	\$48,500
Farm property:		
Matured crops.....	225,150	75,000
Prospective crops.....	145,000	125,000
Livestock and other movable property.....	3,050	6,500
Total losses.....	378,200	255,000
Money value of property saved by flood warnings.....	625,000	275,000

FLOOD-STAGE REPORT FOR JULY 1942

[All dates in July unless otherwise specified]

River and station	Flood stage	Above flood stages—dates		Crest	
		From—	To—	Stage	Date
HUDSON BAY DRAINAGE					
Red of North:	<i>Feet</i>			<i>Feet</i>	
Wahpeton, N. D.-----	6	June 7	June 8	6.4	June 8
Fargo, N. D.-----	17	June 10	June 12	17.7	June 11
ATLANTIC SLOPE DRAINAGE					
Sinnemahoning Creek: Sinnemahoning, Pa.	12	18	19	21.6	18
West Branch of Susquehanna:					
Renova, Pa.-----	16	18	19	18.9	18
Lock Haven, Pa.-----	21	19	19	22.0	19
MISSISSIPPI SYSTEM					
<i>Upper Mississippi Basin</i>					
Meramec: Valley Park, Mo.	14	(¹)	1	21.9	June 29
Mississippi:					
Hannibal, Mo.-----	13	9	10	13.4	10
Louisiana, Mo.-----	12	9	10	12.3	10
Grafton, Ill.-----	18	15	15	12.1	15
St. Louis, Mo.-----	30	(¹)	3	21.7	June 29
Chester, Ill.-----	27	(¹)	5	34.3	June 30
Cape Girardeau, Mo.-----	32	(¹)	10	34.0	1
			9	36.9	2
<i>Missouri Basin</i>					
Big Sioux: Akron, Iowa.-----	12	June 28	3	14.0	June 29
		31	(²)	18.3	Aug. 2
Floyd: James, Iowa.-----	14	June 29	2	16.8	June 30
Grand: Brunswick, Mo.-----	12	(¹)	6	21.8	June 29
Missouri:					
Lexington, Mo.-----	18	(¹)	7	24.3	June 27
Waverly, Mo.-----	18	(¹)	3	21.8	June 27
Boonville, Mo.-----	21	(¹)	6	27.5	June 29
Hermann, Mo.-----	21	(¹)	7	29.4	June 28
St. Charles, Mo.-----	25	(¹)	8	34.8	June 29
<i>Ohio Basin</i>					
Allegheny:					
Red House, N. Y.-----	14	20	20	14.6	20
Warren, Pa.-----	12	20	21	12.5	20
North Fork of Kentucky:					
Hazard, Ky.-----	20	9	9	21.5	9
Jackson, Ky.-----	28	9	10	32.4	9
WEST GULF OF MEXICO DRAINAGE					
Guadalupe:					
Gonzales, Tex.-----	20	6	8	35.1	7
Cuero, Tex.-----	23	7	10	33.0	8
Victoria, Tex.-----	21	7	12	29.6	10
Nueces: Three Rivers, Tex.-----	37	7	13	44.8	10
Rio Grande:					
Rio Grande City, Tex.-----	21	7	7	21.6	7
Hidalgo, Tex.-----	21	9	9	21.2	9
Mercedes, Tex.-----	21	6	11	23.4	9
Brownsville, Tex.-----	18	6	12	19.4	11

¹ Continued from previous month.

² Continued into following month.